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ABSTRACT

How new, reform-oriented elementary teachers teach science in schools that are situated in extant cultures is of great interest to the science education research community as well as to the community at large concerned with continuous teacher education. This paper delimits and summarizes research directions from the cultural perspective. A sample of research that uses a cultural perspective to investigate what happens in a school to a new, reform-oriented elementary science and mathematics specialist teacher in the first two years of full time classroom teaching is presented. By calling for increased use of the school culture, a theoretical perspective in science education research is concluded. (Author/KHR)

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[Return to MCTP research page]

Elementary Science Teacher Education: Contemporary Issues and Practice

"Cultural Considerations"

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Cultural Considerations

Introduction

How new, reform-oriented elementary teachers teach science in schools that are situated in extant cultures is of great interest to the science education research community, as well as to the larger community concerned with continuous teacher education. In this chapter I first delimit and summarize research directions in the cultural perspective. Secondly, I present a sample of research that uses a cultural perspective to investigate what happens in a school to a new, reform-oriented elementary science and mathematics specialist teacher in her first two years of full time classroom teaching. I conclude by calling for increased use of the school culture theoretical perspective in science education research. The school culture perspective has the potential to help us better understand new, reform-oriented elementary teachers' science teaching experiences in the workplace and their career decisions.

Culture and Science Education Research

An emerging field within education is devoted to conceptualizing the role of cultural considerations and its impact on teachers' professional lives. Charron (1991) called for attention to be placed on research that depicted with complexity the social contexts in which all science teachers taught. She based her recommendation on promising insights coming from the use of a social-contexts model in social science research. While science education theorists operating within this broad cultural initiative are similar in viewing the culture concept as paramount, the research directions they have taken differ significantly. For heuristic purposes, I delimit the major research directions taken in this research area as a result of the various cultures thought to impact science teachers professional lives: *the culture of science*; *the culture of the students and teachers*, and, *the culture of the workplace* (referred to as *school culture* by leading theorists). Oftentimes, the boundaries between these three cultural consideration research directions are blended by theorists (as exemplified by Glen Aikenhead and his associates), but for purposes of discussion the proposed divisions I make in the cultural considerations research area have merit.

The culture of science. In this research direction theorists are guided by their consideration primarily of the culture of science, oftentimes as in conflict with the home cultures science teachers and their students bring to the classroom. Science as a discipline is defined as

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a culture that has its own history, philosophy, practices, norms, and community. One aspect of this cultural research direction places focus on describing the nature of science and how a scientifically knowledgeable citizenry might impact beneficially on the larger societal culture in which science teachers and students live (Bevilacqua, Giannetto, & Matthews, 2001). Another aspect of this cultural research direction focuses on a cross-cultural perspective to examine posited cultural clashes between the culture of science as presented in the classroom, and the teachers' and students' home cultures (Aikenhead, 1996; 1998; 2001; Aikenhead & Otsuji, 2000).

The culture of the students and teachers. In this research direction theorists are guided primarily by their consideration of the various cultural backgrounds of the students and their teachers, and how those cultures play out in science teaching and learning contexts. Of key interest to theorists in this cultural research area is to determine how an understanding of the teachers' and their students' cultural knowledge can be used to promote equity by instituting a more culturally relevant science education pedagogy (Atwater, 1989; 1993; Cabello & Burstein, 1995; Fraser-Abder, 1992; Lee, 2001; McGinnis, 1994).

The culture of the workplace (school culture). In this research direction theorists are guided by the notion of a teacher practicing in a workplace culture commonly referred to as school culture. Theorists such as Costa (1997) and Page (1987, 1990) have argued that an analysis of schooling should be "refracted through a schools' culture or meaning system" (Page, 1991a, p. 42). Schools are viewed as microcosms of the society in which they operate. Given a certain time lag, they incorporate a community's values, trends, social conflicts, and inequalities—all the social and cultural proceedings of the society-at-large (Tesconi & Hurwitz, 1974). The schools' meaning system is shaped by what institutional participants (particularly teachers) make of the structural dimensions of schools (i.e., size and location) and of the microprocesses (i.e., curriculum, teaching, and learning). Page (1991b) stresses that what teachers and other school personnel do with these facts is to bend them to "fit their particular circumstances and purposes" (p. 18). Theorists hold diverse definitions of "school culture" (see Page (1991a) for a comprehensive review of the literature). However, their definitions range primarily from culture being an inexplicit dimension of all schools (e.g., a relatively conservative social institution) to a signal to distinguish between schools (e.g., school different personalities or essences).

The School Culture Perspective as a Promising Direction of Research

The cultural view that I take in the remainder of this chapter is aligned fundamentally with the notion of school culture. I place focus on this least explored direction of the three cultural consideration areas of research that I have delimited while acknowledging the tremendous benefit to science education of the other two directions of cultural consideration research. The school culture view forces attention to be placed on the workplace culture in which teachers at all levels and their students interact. The benefit of taking this cultural research direction is a more complete understanding of how culture and its diverse manifestations come to impact the professional lives (including their teaching practices and their career decisions) of science teachers at all levels in specific work environments.

I concur with Page that the strength of the school culture concept is that it supports a view of schools as sociocultural systems "which translate between the classroom and community contexts" (Page, 1991a, p. 42) and that it supports an emphasis on documenting and interpreting teachers' perceptions within those systems. I also believe that "specifying a school's culture is an intuitive, interpretative endeavor....that incorporates the domains in which the participants (and ethnographers speaking to readers) describe" (Page, 1991a, p. 47).

The goal of research using the school culture perspective is both theoretical and pragmatic. In particular, I believe the practical use of a more nuanced theoretical understanding of elementary teachers' cultural considerations to be one of the more new fruitful directions that may be taken in continuous teacher education (pre-service, induction, and lifelong) to support reform-based science teaching practices and improved teacher retention.

The Culture Construct and Anthropology

Those who use the culture construct as a way to understand cultural considerations in science teacher education are using a construct that comes from cultural anthropology. Interestingly, while the culture construct is the central focus of cultural anthropology there are important differences in how members of the field define culture. Therefore, it is worthwhile to conduct a brief examination of the development of the varied views of the culture concept within the field of cultural anthropology. This summary is drawn from a more comprehensive depiction (Levinson & Ember, 1996).

The historical development of the culture construct. An historical examination of the culture construct indicates much change over time in how it has been defined and used. Nineteenth century theorists such as Tylor, Morgan, and Spenser defined culture as equivalent to civilization. The assumption made was that culture was a quality that was linked to the notion of describing civilizations as more or less advanced. Culture was measured by inspection of a broad array of people's capabilities acquired by membership in a society, such as knowledge, belief, art, morals, law, and customs. This view of culture prompted researchers to conduct ethnographies of various societies so that the differing societies could be ordered on a scale of increasing complexity that signified advancement. In this view of culture, all societies followed the same linear evolutionary development model. The only differing variable was in the speed a society developed culture. The key question researchers sought to answer was what produced differences in the developmental speed among societies?

Early twentieth century theorists, led by Franz Boaz began to define the culture concept differently than their predecessors. While culture was still considered a quality consisting of beliefs, customs, and social institutions, it was not linked to an evolutionary model. Instead differences among cultures were attributed to differences in the environmental conditions in which societies lived. Ways of life or culture fit the environment in which they formed but could be influenced by intersocietial communication. Societies whose cultures were the most complex benefited from ample resources and the transmission of technological developments. A fundamental assumption made was that the content of culture was held by the society, not the individual living within the society. In addition, culture was learned not genetically transmitted. Society's culture defined and determined the behaviors of all members of the society.

Later twentieth century theorists questioned these assumptions. Initially, theorists such as Shapir (1924) began to question whether a society's culture shaped each member within it in a similar manner or that a society was characterized by a distinct culture. Eventually, Goodenough (1981) and others took their critical appraisal further. These later theorists argued that members of a society do not all have the same knowledge of customary practices or place an equal amount of significance on them. In fact, depending on the subject matter, considerable variability existed within societies as to how activities were conducted. The primary variable these theorists identified that promoted shared understandings on subject matters was the frequency (and depth) of interaction individuals had concerning such subjects.

The result of these later lines of cultural concept theorizing was the recognition that culture consisted of two distinct but related orders: a phenomenal order and an ideational order. The phenomenal order referred to the patterns an outside observer detected in the conduct of society. These patterns led to descriptions of peoples' way of life and were used to distinguish societies. Culture in this sense is viewed as a societal property. The ideational order, in contrast, referred to what an individual learned in a society that enabled the individual to accomplish desired functions. In this sense, culture was not necessarily something shared by all members of a society. The notion of a common culture or shared understanding was an illusion.

While advocates for the two different orders of culture (phenomenal and ideational) defended their interpretation of culture and attacked the merits of the other's interpretation, Malinowski's work (1944) contributed to a deeper insight into how the content of culture

benefited from consideration of both orders. Malinowski's ethnographic work made evident that there was a complicated interplay between the two orders of culture. In the context of activities, social organizations, beliefs, values and the idiosyncratic purposes of people came together. Later anthropologists such as Geertz (1973) extended the thrust of Malinowski's theoretical position through the examination of shared public symbols. Presently, discussion within cultural anthropology continues on the issue of the two orders of culture and their possible connection.

Use of the culture concept in educational anthropology. In the early twentieth century, Boas (1923) and Malinowski (1944) devoted their attention to refuting a commonly held, yet false, theory about the reputed learning disabilities of immigrant, minority, and lower-class students in public schools. As influenced primarily by Henry Spenser's (1896) views on sociology the canonical view of culture at that time was that certain groups of students came from *lower* cultures in contrast to the other students who came from the *higher* Anglo-American culture. Boas and Malinowski disagreed with that explanation for student differences. Boas argued that student differences resulted from students' differing socioeconomic backgrounds, not as a result of their coming from cultures more or less advanced. Malinowski argued that students who came from cultures differing from the dominant culture portrayed prominently in schools faced academic problems as a result of cultural discontinuities. Two solutions to the problem of underachievement in the schools were proposed: a cultural relativist approach and multicultural education. Work by Spindler (1955) continued this line of research. However, the common misuse of the culture concept as in describing students of color and others who differed in certain traits from their White, middle-class peers as "culturally deprived" persisted up until the 1960s.

Contemporary educational anthropology is united behind the assumption that school-based learning is a form of cultural transmission. Wolcott (1991) broadened the view of cultural transmission in schools to include not only a focus on the role of adults but a focus on children also as actively. The consensus among educational anthropologists is that the notion of cultural discontinuities is the primary explanation for the learning difficulties of students coming from home cultures that differs from the dominant culture expressed in schooling (Erickson, 1993). Of key interest is to understand why cultural discontinuities affect certain groups differentially. Ogbu (1992) suggested that a solution to this problem came from distinguishing between the types of cultural differences that existed for certain groups in school settings. He proposed that groups (such as Asian Americans) which believed they could overcome cultural barriers by learning the behavior and language of the members from the mainstream school culture while maintaining their own cultures were less affected. Alternatively, he proposed that those groups (such as African Americans) which believed that they must give up traditional ways that were stigmatized by the mainstream culture before they could learn the behaviors and language of the dominant culture expressed in school settings fare less well.

A Sample of Research

The following sample of research that uses the school culture perspective in elementary science education is drawn from the work of McGinnis, Parker, & Graeber (2000). In our study of five new, reform-prepared elementary and middle level science and mathematics specialist teachers' professional lives, my associates and I used an analytical framework proposed by Veenman (1984) as a way to understand the role of the teachers' perspective of school culture. This analytical framework consists of two components, a focus on the individual teacher (intentions, needs, and capabilities), and a focus on their perception of the school culture as impacting the enactment of reform-minded practices such as (mandated state and district demands, and school level supports and constraints). Data collected include: the perspectives of the participating new, reform-oriented elementary teachers of science and the vision of science instruction as promoted by those who exert power in the participants' schools, their principals.

Context of the study. The Maryland Collaborative for Teacher Preparation (MCTP) is a National Science Foundation funded statewide undergraduate program for students who plan to become specialist mathematics and science upper elementary or middle level teachers.

Teacher candidates selected to participate in the MCTP program in many ways were representative of typical teacher candidates in elementary teacher preparation programs. They were distinctive by agreeing to participate in a program that consisted of an extensive array of mathematics and science experiences (formal and informal) that make connections between the two disciplines.

The goal of the MCTP is to promote the development of professional teachers who are confident teaching mathematics and science using technology, who can make connections between and among the disciplines, and who can provide an exciting and challenging learning environment for students of diverse backgrounds (University of Maryland System, 1993). This goal is in accord with the educational practice reforms advocated by the major professional mathematics and science education communities (National Council of Teachers of Mathematics [NCTM], 1989, 1991; American Association for the Advancement of Science [AAAS] 1989, 1993; Research Council [NRC] of the National Academy of Sciences, 1996). The MCTP is designed around these salient reform-based recommendations:

- new content and pedagogy courses that model inquiry-based, interdisciplinary approaches combined with regular opportunities for teacher candidate reflection;
- the participation of faculty in mathematics, science, and methods committed to modeling best teaching practices (especially by diminishing lecture and emphasizing problem-solving);
- the development of field experiences in community schools with exemplary teachers trained to serve as mentors;
- the availability of summer internships in contexts rich in mathematics and science; and
- the support of new teachers by university and school personnel during their first years of teaching.

Theoretical assumption and research questions. A fundamental assumption of the MCTP is that changes in pre-secondary level mathematics and science educational practices require reform within the undergraduate mathematics and science subject matter and education classes teacher candidates take throughout their teacher preparation programs (National Science Foundation, 1993). In earlier research my associates and I have reported that the MCTP undergraduates indicated that they held notions about the nature of mathematics and science, and about the best ways to teach mathematics and science, that are compatible with the MCTP program's reform-minded goals (McGinnis, Kramer, Graeber, Parker, 2001; McGinnis, Kramer, Shama, Graeber, Parker, & Watanabe, in press). That is, the MCTP interns intended to use constructivist instructional strategies, to emphasize connections between mathematics and science, to use technology when teaching mathematics and science, and to encourage students from diverse backgrounds to participate in challenging and meaningful learning.

In this study, we wanted to determine what happened to the new MCTP teachers' vision of teaching as reflected in their classroom practices and their discourse during their first two years of full time teaching. In particular, we wondered if their vision would remain stable or would it change (and if so, how and why)? We were aware that schools are characterized by "dynamic conservatism" (Schön, 1987) in that the dynamic pulls teachers back to a status quo which oftentimes remains unchallenged. We anticipated that the new MCTP teachers' reform-oriented beliefs and actions would run into conflict at times with the status quo and were curious to document and to learn from these as yet unknown situations.

Two research questions guided the study:

1. As they proceed through their induction years, how do new specialist teachers of mathematics and science who graduate from an inquiry-based, standards-guided innovative undergraduate teacher preparation:
   (a) enact their roles as teachers; and,
   (b) think about what they do when teaching science and mathematics with upper elementary/middle level students?
2. What supports/constraints impact the introduction of new practices (reform-based) by new specialist teachers of mathematics and

science who graduate from an inquiry-based, standards-guided innovative undergraduate teacher preparation?

Mode of inquiry. We took a symbolic interactionist theoretical stance in this study (Blumer, 1969; Denzin, 1978). The symbolic interaction theoretical stance makes the assumption that social reality is a social production (Woods, 1992). Meanings are constructed by people through interactions; meanings are not inherently linked to inanimate objects or events. A central premise is that inquiry must be grounded in the empirical environment under study (van Sickle & Spector, 1996). This theoretical position also requires the researchers to commit to a significant period of time working in the context of the study. This theoretical position places emphasis on the social construction of meaning in a culture through viewing the process of how individuals define and interpret each other's acts. By carefully examining individual's interpretations of each others acts assertions are made as to how these interpretations sustain or transform the way they view their culture which guides they way they act and interact.

In this study, the symbolic interaction theory provided guidance for the roles of the researchers and the interpretative domain of the study (LeCompte, Millroy, & Priessle, 1992). The researchers held the belief that their research was a social production symbolically negotiated between the researcher and participant. Thus, explicitly revealing the purpose of the research to the participants and maintaining an openness of mind regarding interpretations of the participants' beliefs and actions complemented the research methodological approach. Communication between the researchers and with the participants regarding subjective viewpoints became imperative to conduct within a group. As a group, we researchers made sense of our experiences by revealing our different perspectives. Qualitative research assumes that there are multiple realities constructed as a function of personal interaction and perception (Merriam, 1988, p. 17).

Study participant and research site. For purposes of this research sample only one of the five study participants is presented. She was selected to illustrate that even in the most supportive of contexts the school culture concept has considerable interpretative power. Interested readers are directed to the McGinnis, Parker, & Graeber (2000) study for additional cases, most of which do not illustrate as supportive of a context. What follows is a brief description the participant and her school context (pseudonyms used in all cases).

Ms. Susan Lee was an Asian American woman, a traditional college student who finished her undergraduate elementary teacher education program in four years. She completed a summer MCTP research internship at a space and aeronautical lab. Ms. Susan Lee taught fourth grade at Overlook Elementary School. Overlook Elementary School had not met any of the local standards on the district's criterion referenced tests. The school was attended by 42.2% Hispanics, 28.5% African Americans, 21.2% Whites, and 7.6% Asian. Many students (62.2%) received free or reduced meals. The school's mobility rate was 24.1%.

Findings. Our findings are presented as inside and outside perspectives in response to our two research questions. The inside perspective consists of summaries of our participant's comments. The summaries are supported by exemplar participant comments. We believe that the use of the participant's inside perspective (emic voice) demonstrates respect for our participant (allowing her voice to be preeminent) and enhances the study's credibility (Van Maanen, 1995). The outside perspective (etic voice) in this analysis is composed of vignettes of the participants' lessons, their students' comments on the lessons, the participants' principal's voices, and the researchers' theoretical framework on the data. We believe that these two data representation strategies provide the reader with a rich depiction of the participant's professional life that align with the spirit of recommendations made by Page (1991a) in her studies using a school culture perspective. Specifically, while the emic voice permits the participant to tell from her standpoint the story of her professional life, the etic voice provides the reader a perspective of how the participant was perceived by others in her particular school culture.

To answer our first research question ("As they proceed through their induction years, how do new specialist teachers of mathematics and science who graduate from an inquiry-based, standards-guided innovative undergraduate teacher preparation, (a) enact their roles as

teachers, and (b) think about what they do when teaching science and mathematics with upper elementary/middle level students?") we analyzed data collected from the individual and group audiotaped and transcribed interviews, videotaped classroom lessons, participant reflective writings, student reflections, and classroom artifacts. As the lead researcher, I took the lead in identifying a pool of comments by each participant that most cogently reported the participant's perspectives. The participant's comments then were read by my coresearchers who were asked to select the most representative comment for inclusion in the narrative (or to suggest additional comments that I may have overlooked). When disagreements among the researchers emerged (in a limited number of instances), the decision on which comment to include was settled by appeal to the participant.

Inside Perspective. The participant's individual and focus interviews conducted over two school years were the data sources for the participant's view of how she enacted the role of a reform-prepared teacher, and what she reportedly thought about while teaching content in their school contexts.

Enact her role as a teacher. As a teacher, Ms. Lee described herself consistently as holding a student-centered perspective. She enacted that perspective by using cooperative learning activities that she considered constructivist and that sought to make connections among different disciplines. She preferred to use alternative assessment strategies in her practice. In comparing how she taught with the other teachers in her school, she thought of herself as a more effective teacher. She stated,

> I'm teaching an upper level math, a high group, and I'm using a lot of the activities that we did, the hands-on, constructivist activities that we learned in our courses, especially in the methods. I'm using a lot of those activities from my MCTP science methods professor because it goes along very nicely with the hands-on, constructivist deals, and the kids are doing great with it. They look forward to coming to math and science, and also I'm integrating the math and science activities in with the other subjects, too, like the writing activities, and so it actually is an integration of all subjects, but it's working out very nicely. We just finished a unit with a lot of hands-on activities, and actually I had the students work in groups....I notice that my teaching is a lot different from the ones at the school. Most of my strategies are better. They have one other new teacher, but everyone else has been teaching more than five, ten, fifteen, maybe even thirty years, and I guess it's different in that for all of them there is more direct instruction, and more of, like, a lecture type, and there is a little bit of hands-on. (Fall 1998, interview)

Think about what she does when teaching science and mathematics with elementary students. Ms. Lee reported that when she was teaching mathematics or science, a central thought she held was a commitment to make connections between the disciplines. She kept in mind a model of her MCTP instructors' teaching method to guide her actions. Over time, she increasingly began to compare the manner in which she taught to the other teachers' method she observed in her school. As she stated,

> I model everything I do after what I learned in the MCTP. When I'm teaching a science unit I tie in the science with the mathematics. And when my students do science, they know it's not just science, we're also doing mathematics. When we are doing mathematics, we do have reading, writing and science, too. (Spring 98, interview)
> The way that I teach is more that they're [her students] building the knowledge, so it's not just memorizing facts [like the other teachers do]. Everything is connected, and so they never question why they're learning something....And so in terms of understanding, I think that this approach is just so much better. I'm very pleased with the results that I am getting in the classroom. (Fall 1999, interview)

Outside Perspective. The primary data sources of the outsider perspective of how the participants enacted their roles as reform-prepared teachers were videotaped observations of the participant lessons and elementary/middle school student comments of their teacher's mathematics and/or science teaching practices, when available. What follows is a vignette of classroom teaching performed by Ms. Lee during the study period. In this vignette, Ms. Lee exhibits practices aligned with recommendations contained in standards-related documents produced by AAAS, NRC and NCTM: teaching for understanding; making connections across the curricula; using non-routine, relevant and problem-based cooperative learning activities; emphasizing student discourse and reflection; and using alternative assessment.

Fall 1998 Vignette.

> Ms. Lee introduces the lesson to her diverse students by stating that there is something special going on the entire month. Student's hands go up, and a student offers, "It's Asian Pacific Heritage Month." Ms. Lee responds, "That's right, Asian Pacific Heritage month. I am very excited to bring something from my culture, from China, to the classroom during our science time. We have

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been studying ecosystems. Can someone remember what you need to grow a plant?" The class begins listing things that are needed to grow a plant: soil, water, air, the right temperature, and light. Ms. Lee writes the students' suggestions on the chalkboard. The students are eager to give answers; they almost all have their hands up. Ms. Lee states, "Today, you are going to plant something special, it is called the Dow Gawk. Can everyone say that?" Ms. Lee writes the words on the board and states, "This is also called the Chinese Long Bean. Let me tell you a little about the Chinese Long Bean before everyone is going to plant her or his own Dow Gawk plant. There is something special about this Dow Gawk which is similar to the string beans that we eat. What does the string bean look like?" Students share responses with each other in pairs. They comment on such things as "It is long," "It is nasty," "It looks like a pod." Mrs. Lee praises the students' comments and continues to tell the students about the Dow Gawk. She tells them how large the bean grows, to a size "most people would not expect." She tells the students that she won't tell them how large their plants will grow, but that the plant will grow out of the cups in which they will plant the seed. Later they will have to plant the plant into a larger pot. "Eventually you'll have to grow it hanging because it won't grow straight."

Ms. Lee passes out the seeds and asks the students grouped in cooperative groups of four to observe their individual beans and to write down their observations on an index card. She asks for a student volunteer to pass out the index cards. While Ms. Lee places a bean seed on each student's desk, she says, "There is something else interesting about this bean seed, so I want you to look at it and think about ways to describe it." Students attentively study the passed out bean seeds. Ms. Lee states, "Remember, you should be describing your bean seed on the index card and be writing a sentence or two describing the bean." Ms. Lee asks for volunteers to share their observations. She selects equitably both girl and boy volunteers and students of color and limited English speakers to respond. Students share their observations such as the size of the bean, the color, and the texture. Ms. Lee praises the students for their observations.

She continues her lesson by stating, "We will be planting these Dow Gawk seeds today and charting their growth until the last day of school. You are welcome to continue the growth measurements in the summertime, also." A female student asks if you can eat the beans. Ms. Lee replies that yes, you can eat them or you could replant them. Ms. Lee shares with the class that her mother plants them in her vegetable garden. She tells the students that if they take care of their plants, the plants will grow very large, larger than they expect probably. The students begin to ask how large the beans will get. Ms. Lee replies, "You will find out."

Ms. Lee shows the class some graph paper. She then tells the class that every other day in class they will be charting and graphing the beans' growth. Next, Ms. Lee points out to the class that the beans are wet and asks the class why she has made them wet. One student suggests that by soaking the bean seeds it speeds up their germination. Ms. Lee praises the student for his answer and agrees with his thinking.

Ms. Lee asks for a volunteer from each table to come and retrieve supplies. Hands shoot up. A volunteer from each table retrieves supplies for each table. Ms. Lee asks the students to observe the cup in which the beans will be planted. One female student points out that there is a hole in the bottom. Ms. Lee asks, "Why do you think I put holes in the bottom of the cups?" A male student suggests, "So if you add too much water the cup won't flood." Ms. Lee then asks, "Does anyone want to add anything?" Another female student offers that the hole could make it easier for them to observe the plant root system. Ms. Lee shares with the class that while her intent in putting the hole in the bottom of the cup was to allow excess water to seep out she also now thinks the hole will indeed help with observations of the root structure.

Ms. Lee asks the class how far down they should plant their seeds. A male student suggests that if they plant the seeds too far down, the plant won't be able to reach the top. Ms. Lee demonstrates to what depth to plant the bean seeds. The students plant their seeds. She instructs the students to put their index cards underneath the cup of seeds, and then to place the cups in the tray at the center of the table.

Ms. Lee hands out graph paper to every student and informs the class that they will begin the graph today. She states, "You will be doing a line graph. You may remember that we have done this before in math class." She asks the class, "What are the types of things you need for a line graph?" Students raise their hands and one boy offers that the graph needs a title. Ms. Lee asks the class, "What would be a good title for this graph?" A student suggests "Dow Gawk." Another student suggests, "Planting a Dow Gawk." Ms. Lee passes out rulers. Ms. Lee states, "Share something else you need to make a line graph." A female student suggests lines. Another female student suggests numbers. A third male student suggests labels. Ms. Lee writes all of the students' suggestions on the board. She tells the students that the vertical axis should be "Measurement in centimeters." The students label their graphs. Next she asks, "On the bottom axis what should you put? We will be measuring the growth every other day, that is a huge hint. " Several students hands shoot up. "SO what should we put on the horizontal axis?" A student suggests, "days."

Ms. Lee walks around the room checking students' graphs. "A reminder-the days are on the bottom axis, the horizontal axis, the axis that is lying flat. And the measurement is on the vertical axis, the one that is going up and down."

The lesson ends with the students cleaning up their desks and putting their cups on the window sill.

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To answer our second research question ("What supports/constraints impact the introduction of new practices (reform-based) by new specialist teachers of mathematics and science who graduate from an inquiry-based, standards-guided innovative undergraduate teacher preparation?) we analyzed data collected from the individual and group audiotaped and transcribed interviews (participants and principals), and participant reflective writings.

Inside Perspective. The individual and focus interviews conducted over two school years were the data sources for the inside perspective on perceived supports and constraints the new teachers faced in enacting their reform-based visions of practice in their schools.

Supports. A common theme expressed by all the five new teachers in the study was the direct impact of the particular school culture on what supports the new teachers had available. Ms. Lee taught in an elementary school that was distinguished by the high percentage of English as a Second Language (ESOL) students (12.8%) who were at variable levels of English proficiency. Ms. Less characterized many of these students' parents as illiterate, which caused complications in her ability to explain to them her rationale for her student-centered, active

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teaching. However, a support she found, due to the active nature of her learning activities, was in the positive reaction of her students' parents to the students' ability to show at home what they did in her class. As she stated,

> What I've noticed, what I've found out, is that a lot of the parents are illiterate and they don't really, the kids don't really have much support at home, and so a lot of the things we do in class is more hands-on so that they can be more independent. Because at home they have to be that way, a lot of them do. The kids are actually able to tell their parents what they did. They can explain, "Well this is how we learned it." With the hands-on things that we did you don't have to read a worksheet and say, "Well, Mom, Dad we learned about electricity today. This is the worksheet that we did." The parents come in and they're just so excited. Sometimes they come in and they say, My son is just so happy to be in your class and he's learning so much. Everyday he comes home and tells me everything that he learned throughout the day." (Spring 1999)

Another type of support on which Ms. Lee relied to implement her vision of a reform-minded practice was her learning experience in her undergraduate MCTP teacher preparation program. Specifically, the way she was taught in her introductory MCTP physics class and the activities which she participated in her MCTP science methods class assisted her. She stated,

> Our MCTP classes [content and pedagogy] were taught in a constructivist manner, so our learning was constructivist, too. They built on our prior knowledge, and those kinds of things, like, all these little facts that I learned in my MCTP Physics course. I didn't forget the knowledge, because the professor built a solid foundation of the science and the math. Those kinds of things I didn't forget, and I'm using that very nicely here in the classroom. (Fall 1998)

Constraints. The constraints for reform-based practices identified by our five MCTP study participants were shared and also idiosyncratic. The list of shared constraints included: non-solicited ideas on how to change the participant's practices; the number of mathematics objectives to meet; the shortage and availability of computer equipment; the diverse level of student abilities; the science kits' prescribed curriculum and schedule; the prescribed science and mathematics curricula; the district's ongoing student testing of instructional outcomes; the frequent instructional interruptions; the number and extent of standardized student testing; the more experienced teachers' expectation that the new teacher would become less active and less innovative over time; and, the suspicion of some parents to alternative assessment ideas.

As stated by Ms. Lee,

> Obviously if there's more people watching, there's more people with ideas, and they're going to be, you know, giving suggestions, and it's not always going to be positive. They're gonna say, "Well, why don't you do it this way?" I mean, that will place a constraint.

The list of idiosyncratic constraints identified by our five MCTP study participants included: student expectations of being taught in a traditional manner; standardized student testing; communication with non-English proficient student parents; availability of technology equipment; student subject rotation from teacher to teacher; prescribed curriculum and schedule of the science kits; standardized testing of short-term instructional outcomes; diverse abilities of the students; team concept of teaching; and, excessive parental involvement. As stated by Ms. Lee,

> I do feel very comfortable teaching in the MCTP manner. My problem is I'm starting to have tension with my other two teammates because I'm teaching differently than they are. And, I am. I prefer to teach this way and I don't see myself changing. And although I am the younger one, I don't follow how they teach. And I've had a lot of parents talk to me and tell me that they want their child to be in my class next year—and the principal is saying all these things. I know I'm not doing anything wrong and the kids are learning so much this year and so, like everything I learned from MCTP physics, just like the hands-on lab things. My teammates keep on pushing these textbooks in my face and they keep on saying, Susan, you have to use this. You have to use this. The students have to answer questions from the textbook. We do answer questions, I mean, we do write in a daily log and we do discuss the book, but we don't do the whole section in a book chapter and then answer the corresponding questions to it.

Outside Perspective. The primary informants of the outsider perspective were the participant's principals. As building managers and instructional leaders of their schools, their perspectives were viewed as particularly powerful within the new teachers' school cultures. During the summer immediately following the new teachers' first teaching year, they were asked to reflect on both the supports and the constraints (or, as one principal renamed it, the "challenges") the new teachers faced in enacting their reform-based visions of practice in their schools.

Supports. The supports identified by the MCTP new teachers' school principals were diverse. These supports included: the positive reaction to the new teachers' practices by colleagues, students, and parents. The principals also voiced their appreciation of what the new teachers brought to their schools in oftentimes glowing terms, referring to the MCTP study participants' nominations for "Teacher of the Year" in several instances. The following statements by Ms. Lee's principal exemplify the administration's high level of support of the new teachers:

> She's one of the best prepared people to take on [our school district's] public schools curriculum in those two areas [mathematics and science] that I've had the privilege of working with in the last, at least, ten years.... I nominated her, along with the PTA and other community members and staff, for the First-Year Teacher Award. It's a very prestigious award. It's a national award. To put it in a better perspective I've never nominated a first-year teacher for an award, for the First-Year Teacher Award or those types of awards. I never felt that I had one that was of this caliber. (Ms. Lee's Principal)

Constraints. The constraints identified by the school principals for the five study participants varied by individual. In Ms. Lee's case, the principal did not identify any constraints.

Discussion. We believe that this study adds to the understanding of what happens to reform-minded new teachers in science during their first years of teaching practice. Contrary to other theorists who emphasize use of a developmental framework or cognitive developmental framework to understand the induction of new teachers, we find it more useful in our thinking of what happened to Ms. Lee (and to our other four study participants) to focus primarily on a cultural perspective.

Ms. Lee intended to enact reform in her mathematics and science practices when she entered her workplace. In particular, as earlier quoted in this chapter, Ms. Lee was prepared to make connections between mathematics and science, to emphasize problem-posing, to use cooperative learning groups, to infuse technology in their lessons, to use alternative assessment strategies, and to emphasize content and process. In addition, Ms. Lee stated,

> I teach math and science in a completely constructivist approach. I do use some directed instruction, but I do encourage a lot of cooperative learning and letting the children figure things out rather than me telling them everything. We use manipulatives, learning stations, where they formulate ideas on their own. It's more independent. (Ms. Lee)

This theme of reform-minded innovation in mathematics and science teaching flowed throughout Ms.Lee's reflections on what she intended to do in her practices. Similarly, her teaching (as evidenced by her vignette) suggested that she sought, when possible, to enact reform-minded practices in her science and mathematics classes. The primary need Ms. Lee had, therefore, was a workplace that supported these intended practices.

Ms. Lee constructed a favorable perspective of her capabilities (level of content knowledge and abilities in reform-based pedagogy) by comparing herself in her workplaces with the perceived capabilities of her non-MCTP prepared teaching colleagues. As stated by Ms. Lee,

> I even noticed that I have more content knowledge in math and science, more than the veteran teachers that are here. And they're finding that they need to ask me some science-related questions. I'm not saying that I am the guru and the expert here on science but I find that I'm pretty prepared for the content area. [Ms. Lee]

In Ms. Lee's case, she entered a school culture in which she seemingly flourished[1]. However, this was not the case for the majority of our five study participants. In Ms. Lee's case and in the cases of all the other new, reform-oriented elementary science and mathematics teachers we examined over a two-year period we found that as our new teachers became enculturated into their schools, they implemented "social strategies" to respond to perceived constraining structures. Social strategies in this study are actions individuals take in reaction to perceived coercive power in a community setting. The social strategies the new teachers developed to remain in teaching were *resistance and moving on*.[2] These strategies were not mutually exclusive, but were used as the new teachers thought appropriate in response to specific instances of perceived power in their school cultures.

Resistance. In several instances the new teachers expressed resistance in their actions toward traditional ways of thinking about mathematics and science teaching they detected in their school cultures. For example, when several veteran teachers reacted negatively to some of Ms. Lee's reform-minded ideas, she engaged in resistance by defending her practices. As she stated,

> We had a team meeting, and they [her teacher teammates] came up to me, and they just said, I mean, of course they were positive at first, I mean, we get along very well, but then they're starting to say things like, they think that my method is just a little bit, well, they think they *cover* [participant's emphasis] more things. I said, "Well, you may cover more things and they may remember it short-term, like on short term to take a test, but what about later on when you're building from it?"

Moving on. In one case when the perceived instances of coercive power within a school culture became problematic, the new teacher decided to transfer out of her school to another school within the school district. She stated that if that action did not improve her professional life her next step would be to leave teaching as a career. In another case, the new teacher decided to break completely with the broader-in-scope context in which his school culture was situated. He departed his school district to take a teaching position in a Native American school that was located in a different state.

In Conclusion

My associates and I draw several implications from the study we conducted of a group of five new, new reform-oriented teachers that included Ms. Lee. First, the study suggests that a reform-based mathematics and science teacher preparation program can recruit, educate, and graduate a cadre of new, reform-oriented teachers who are employed by schools. Evidence collected indicates that new teachers from such a teacher preparation program have the capabilities and intentions to teach mathematics and science in a reform-minded manner by using high-quality science and mathematics.

Second, the study suggests that the new teachers' perceptions of their school cultures in which they began their teaching practices is a major factor in the degree and manner in which reform-minded mathematics and science teaching is implemented. The supports and constraints an individual teacher encounters on a daily basis, particularly from individuals with power over their work lives are noticed by new teachers and influence how they perceive their school culture (Williams, 1961), and their curricular, instructional, and assessment actions.

Finally, if this study's findings are supported by future research, to enact reform and to retain new, reform-prepared teachers a key implication is that the new teachers fare better when they are employed in supportive, reform-oriented school cultures rather than in other environments. While our findings show that in situations in which reform-based teaching is discouraged, some reform-prepared new teachers do not leave but, instead, elect to continue their careers by altering their practices to fit in with extant traditional practices, the loss of reform in those contexts is a costly impact. We posit that if better matches are made initially between reform-prepared teachers and school cultures, the extent and the quality of reform-based practices in mathematics and science teaching will increase as will the retention of more newly prepared teachers within school cultures. We also wonder what can reasonably be done in teacher preparation to more adequately prepare new, reform-minded teachers to enact reform-based practices in school cultures that are not initially supportive? We believe a first step during their teacher preparation programs would be to alert them to the concept of school culture. A second step would be to work with them in collaboration with their school districts' induction prog.·m as they reflected on the impact of school culture on their practices and career decisions. At a minimum, presenting career decision options that are less climactic than the social strategy of exiting for those experiencing severe cultural discontinuity would be beneficial.

The school culture perspective offers a view of what can happen to new, reform prepared teachers in their induction years. This theoretical perspective underscores particularly the need for additional attention toward alerting new reform-minded mathematics and science teachers as to the potential consequences of accepting employment in non-supportive school environments. Recent studies by Jerald & Boser

(2000) and Ingersoll (1999, as cited in Britton, Raizen, Paine, & Huntley, 2000) suggest that many schools are problematic workplaces for new teachers. Specifically, new teacher attrition is now 23% within the first three years of practice. Job dissatisfaction is reported particularly by new mathematics and science teachers as a major reason for exiting.

Consequently, my associates and I recommend increased attention be directed toward investigating the school cultures in which new, reform-prepared teachers work. And while we place considerable value on documenting and interpreting the perception of school culture from the new teachers' perspectives, we believe also that documenting and interpreting simultaneously other's perception (beyond those held by the researchers') of the new teachers' school cultures can be useful. Our work suggests that school cultures, from the new teachers' perspective, actively support and respect the reform-oriented culture the new teachers bring to the workplace result in the most contented, stable, and effective personnel. In school cultures, from the new teachers' perspective, pose a culture discontinuity between their expectations and their circumstances. Yet our work suggests the opposite effect. The latter situation, unfortunately, predominated in our extended investigation of a select sample of new, reform-oriented elementary teachers with significant science teaching responsibilities. It is our hope that this situation can be improved by recognizing the power potentially of the school culture concept in the conceptualization and implementation of all aspects of elementary science teachers' continuous professional education (teacher preparation and inservice).

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[1] However, in private conversation with the lead researcher Ms. Lee expressed increasingly dissatisfaction with the professional development opportunities at her school. Since she saw herself as a lifelong learner with a strong desire for intellectual growth, this dissatisfaction grew to dominate her career decisions. Consequently, at the end of her third year of teaching, she resigned her teaching appointment to begin full time graduate studies in elementary education at an out-of-state institution of higher learning. She expressed uncertainly as to her career plans following completion of her masters degree program.

[2] The social strategy *exit* (ending the teaching career by resignation) was an option identified by our participants that they would take if the other two social strategies, *resistance* and *moving on*, did not improve their circumstances. Ms. Lee eventually took this social strategy.

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